To Whom It May Concern:

This is a review of article **LF11708** entitled "First Observation of Heavy Baryons Σ_b and Σ_b^*" by T. Aaltonen, A Abulencia, J. Adelman, T. Affolder, et al.

This article will be of high interest to the particle physics heavy flavor community and it should be of general interest to the physics community that the 3-quark mass spectra containing a b-quark follows the expected pattern seen in lower mass 3-quark spectra. The Σ_b states and Σ_b^* states were predicted several years ago, but these states have not yet been observed. The interesting numbers to determine are the masses and the natural widths of the states. This paper reports the masses for the charged states; the neutral states are not studied. From the mass values, one can determine the hyperfine and isospin mass splittings. The Σ_b states and Σ_b^* states decay strongly and as reported the natural widths vary from 2 to 20 MeV/c^2 in the paper by Korner, Kramer, and Pirjol.

The crux of the paper is that two independent, charge-signed invariant mass distributions are simultaneously fit using an unbinned maximum likelihood fit for four mass peaks with a constraint on the mass differences. The samples are acquired without particle identification by using Λ_b^0 events selected via the decay chain $\Lambda_b^0 \to \Lambda_c^+\pi^-$ with $\Lambda_c^+ \to pK^-\pi^+$. Kinematics and decay length fits are used to obtain a clean Λ_b^0 sample.

In the abstract four distinct mass values are reported for the four $\Lambda_b^0\pi^\pm$ resonances, yet the values are correlated via their fitting constraint that $m(\Sigma_b^{*+}) - m(\Sigma_b^+) = m(\Sigma_b^{*-}) - m(\Sigma_b^-) = \Delta_{\Sigma_b^*}$. Also there is no mention of the significance of the observation. It would be fairer to report the values that they directly measure, namely $\Delta_{\Sigma_b^*}$, ($m(\Sigma_b^+)$ or $Q_{\Sigma_b^+}$), and ($m(\Sigma_b^-)$ or $Q_{\Sigma_b^-}$) and interpret the states within the paper. I also think the paper should report a significance of observation of 5.2σ for observing all four states.

Further, I have a mild concern about the title. It would be more accurate to say "First Evidence of Heavy Baryons ...". Most of individual states have a significance around 3 standard deviations. Usually the term discovery or observation is reserved for the 5 standard deviation level, unless one knows the mass and width of the state. In this case it is the pattern of all four states that yields a 5σ effect.

The fitting description is a bit terse and it would aid the reader to add more information. The natural widths used in the fit for the Σ_b^+ and Σ_b^{*+} states should be reported rather than referencing a long theory article. It would also be nice to report what the detector resolution for the dominant narrow core is for the Σ_b^+ and Σ_b^{*+} states. Providing this information would allow the reader to gain insight on whether the difference in widths shown in figure 2 is a result of a difference in natural width or the detector resolution.

The background parameterization looks pretty good, but I don't see a mention of possible higher mass Λ_b^0 and Σ_b states. The background under the $\Sigma^{(*)}$ is determined from a fit of the Q distribution up to 500 MeV/c^2. The undiscovered, but expected Λ_b^0 and Σ_b states at higher mass could distort the "combinatoric" background at high Q value and lead to a flatter background. As the background is a fixed component in the $\Sigma^{(*)}$ fit, the systematic effects from varying Q background range - say 200 MeV/c^2, 300 MeV/c^2, 400 MeV/c^2 and the default at 500 MeV/c^2 should be considered. The background fit determination also looks to be tricky in terms of how many low mass bins (below 40 MeV/c^2) are used.

The summary paragraph on page 13 is carefully crafted to say "we observe" a signal of four states. It does say that the widths of the four states are consistent with expectations, but we were not provided sufficient information to assess the sensitivity of the signal to the natural widths of the states. This is partly a question of detector resolution in the Q range where the signals are studied. I presume that there is insufficient statistics to let the width float in the fit. (One could have just two widths - one for the Σ_b and one for the Σ_b^*.)